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WATER QUALITY CONTROL STUDY, CHIKASKIA RIVER BASIN, KANSAS AND OKLAHOMA

Public Health Service
Dallas, Texas

August 1965

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WATER QUALITY CONTROL STUDY CHIKASKIA RIVER BASIN KANSAS AND OKLAHOMA

Study of Needs and Value of Storage for Water Quality Control

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII
Dallas, Texas

AUGUST 1965

WATER QUALITY CONTROL STUDY

CHIKASKIA RIVER BASIN

KANSAS AND OKLAHOMA

Abstract

A study has been made of the need for and value of storage in Caldwell and Corbin Reservoirs for water quality control purposes in the Chikaskia River basin. The investigation revealed an immediate need for water quality improvement in Bluff Creek downstream from the Caldwell Reservoir site. Anticipated seepage losses from this reservoir will be adequate to maintain satisfactory water quality for expected uses and have attributable value. No need was found for storage for water quality control purposes in either reservoir. Future municipal and industrial water uses, used as the basis for estimating waste releases for this study, were provided by the Bureau of Reclamation with the exception of those projected for the Blackwell area which were adapted from a previous Public Health Service study.

Prepared for

U.S. DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Oklahoma City Development Office

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII
Dallas, Texas

AUGUST 1965

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I. INTRODUCTION

Request and Authority

In a letter dated August 28, 1964, the Bureau of Reclamation, Oklahoma City District Office, requested the Public Health Service to study the proposed Corbin and Caldwell Reservoir projects and ". . . prepare a report on the pollution control benefits the project(s) might provide. . . ."

This study has been made in accordance with the Federal Water Pollution Control Act, as amended, (33 USC 466a(b)).

Purpose and Scope

The purpose of this study is to determine the need for and value of storage for water quality control purposes to the year 2020 in the Chikaskia River basin, south-central Kansas and north-central Oklahoma, as well as to determine the value of water quality control benefits attributable to the proposed storage projects.

Acknowledgments

The assistance and cooperation of many persons and agencies are gratefully acknowledged. Appreciation is especially expressed to the following:

Kansas State Department of Health, Topeka, Kansas
Kansas Water Resources Board, Topeka, Kansas
Bureau of Reclamation, Oklahoma City, Oklahoma

II. SUMMARY OF FINDINGS AND CONCLUSIONS

Summary of Findings

1. The Bureau of Reclamation study concerns the construction of two multipurpose reservoirs (Corbin and Caldwell) in Sumner County, Kansas, located in the south-central portion of the State near the Oklahoma border. Corbin Reservoir will be located on the main stem of the Chikaskia River while Caldwell Reservoir will be located on Bluff Creek, a tributary to the Chikaskia.

2. The study area consisted, in general, of the seven counties encompassing the Chikaskia River watershed in south-central Kansas and north-central Oklahoma; including the communities of Anthony, Harper, Caldwell, and Wellington, Kansas, and Blackwell, Oklahoma. The 1960 population of these five communities was 24,828.

3. Total water use by study area communities in 1963 averaged 4.4 million gallons per day (mgd). All of the communities provide secondary treatment of sewage at the present time.

4. The quality of the surface and ground water in the Chikaskia River basin is excellent.

5. Projections by the Bureau of Reclamation indicate a total population of 17,320 and a total municipal and industrial water use of 3.52 mgd for Anthony, Harper, Caldwell, and Wellington, Kansas, by the year 2020.

6. Projections made by the Public Health Service in a study for the proposed Corps of Engineers' Kaw Reservoir project indicate a total population of 18,000 and a total municipal and industrial water use of 3.3 mgd for the city of Blackwell, Oklahoma by the year 2020.

Conclusions

1. There is an immediate need for control of water quality in Bluff Creek below the proposed Caldwell damsite. Expected seepage losses of 300 acre-feet per month from this reservoir, when placed in operation, will be more than adequate to meet this need.

2. Based on information presently available, there is no foreseeable need to provide storage for water quality control purposes in the proposed Corbin and Caldwell Reservoirs.

3. The average annual value of benefits attributable to improvement of water quality in Bluff Creek by Caldwell Reservoir is estimated to be $5,130.

4. Benefits to water quality improvement in Bluff Creek by Caldwell Reservoir will be widespread in scope.

III. PROJECT DESCRIPTION

The two Bureau of Reclamation multipurpose projects under study lie within the Chikaskia River basin in south-central Kansas near the Oklahoma-Kansas border. (See figure III-1 at the back of this report.)

The proposed Caldwell Reservoir will be located on Bluff Creek, approximately 20 miles above its confluence with the Chikaskia River at river mile 33, and one mile north of the Oklahoma border. It will provide 69,680 acre-feet of storage with 60,000 acre-feet allocated to flood control and 9,680 acre-feet for fish and wildlife purposes. 1/

The proposed Corbin project will be located on the main stem of the Chikaskia River at river mile 67, about 8 miles north of the Oklahoma border. The project will have a storage capacity of 262,781 acre-feet allocated as follows: Flood control - 98,122 acre-feet; conservation - 154,131 acre-feet; and fish and wildlife - 10,528 acre-feet. 1/

IV. STUDY AREA DESCRIPTION

Location and Boundaries

The Chikaskia River is the principal tributary of the Salt Fork of the Arkansas River. It rises in Pratt County in south-central Kansas and flows 145 miles southeasternly through parts of Pratt, Kingman, Barber, Harper, and Sumner Counties in Kansas, and Kay and Grant Counties in Oklahoma, to its confluence with the Salt Fork River, 26 miles above the junction of the Salt Fork and the Arkansas River. These seven counties compose the study area.

Geography and Topography

The 110 mile long watershed ranges in width from a few miles to about 30 miles, and encompasses a total area of 2,009 square miles, 582 square miles of which are drained by the Bluff Creek tributary.

The upper reaches of the Chikaskia River in Kansas are rolling praries, gradually flattening eastward. The stream channel is usually deep and narrow. In the lower portion of the river, the banks are slightly higher than adjacent lands because of alluvial deposits during high water.

Climate

The climate in the Chikaskia River basin is temperate and dry to subhumid. The average annual temperature is 58°F. and annual rainfall varies from 24 inches in the north to 34 inches in the south. The growing season averages from 189 to 211 days, north to south. 2/

Principal Communities

The principal communities in the study area, as shown on figure III-1, are Anthony on Bluff Creek, Caldwell on Fall Creek, Harper on East Sand Creek, Wellington outside of the Chikaskia watershed on Slate Creek, and Blackwell, Oklahoma, on the Chikaskia River. The 1960 population of these communities is shown in table IV-1.

Table IV-1

1960 Population of
Principal Communities in the Study Area

Anthony, Kansas	2,744
Caldwell, Kansas	1,788
Harper, Kansas	1,899
Wellington, Kansas	8,809
Blackwell, Oklahoma	9,588
TOTAL	24,828

Source: Bureau of the Census 3/

V. WATER RESOURCES OF THE STUDY AREA

Surface Water

There are at present no reservoirs of significant size or yield in the Chikaskia River basin. The city of Wellington, Kansas, has an impoundment on a Chikaskia tributary but withdraws the majority of its supply from shallow wells. Blackwell, Oklahoma, has a small municipal reservoir, but depends mainly on the natural flow of the Chikaskia River.

Streamflow

Thirteen years of records on the Chikaskia River near the Corbin damsite 4/ show an annual mean flow of 220 cubic feet per second (cfs). Shown in figure V-1 is the probability of occurrence of different annual mean flows and on table V-1 the monthly distribution of the low annual flow expected once in 10, 20, and 50 years (90 percent, 95 percent, and 98 percent exceedence intervals).

Streamflow records on the Chikaskia River at Blackwell, Oklahoma 4/ show an annual mean flow of 482 cfs for 28 years. Figure V-2 shows the probability of occurrence of different annual mean flows and table V-1 shows the monthly distribution of the low annual flows expected once in 10, 20, and 50 years.

Streamflow data furnished by the Bureau of Reclamation for Bluff Creek at confluence with Fall Creek 5/ near the Caldwell damsite, show an annual mean flow for 27 years of 133 cfs. However, several extended periods of zero flow have occurred, one lasting 20 months from fall 1939 to spring 1941, and another lasting 15 months during 1956 and 1957.

On figure V-3, the probability of occurrence of different annual mean flows is shown and table V-1 shows the monthly distribution of the low annual flows expected once in 10, 20, and 50 years.

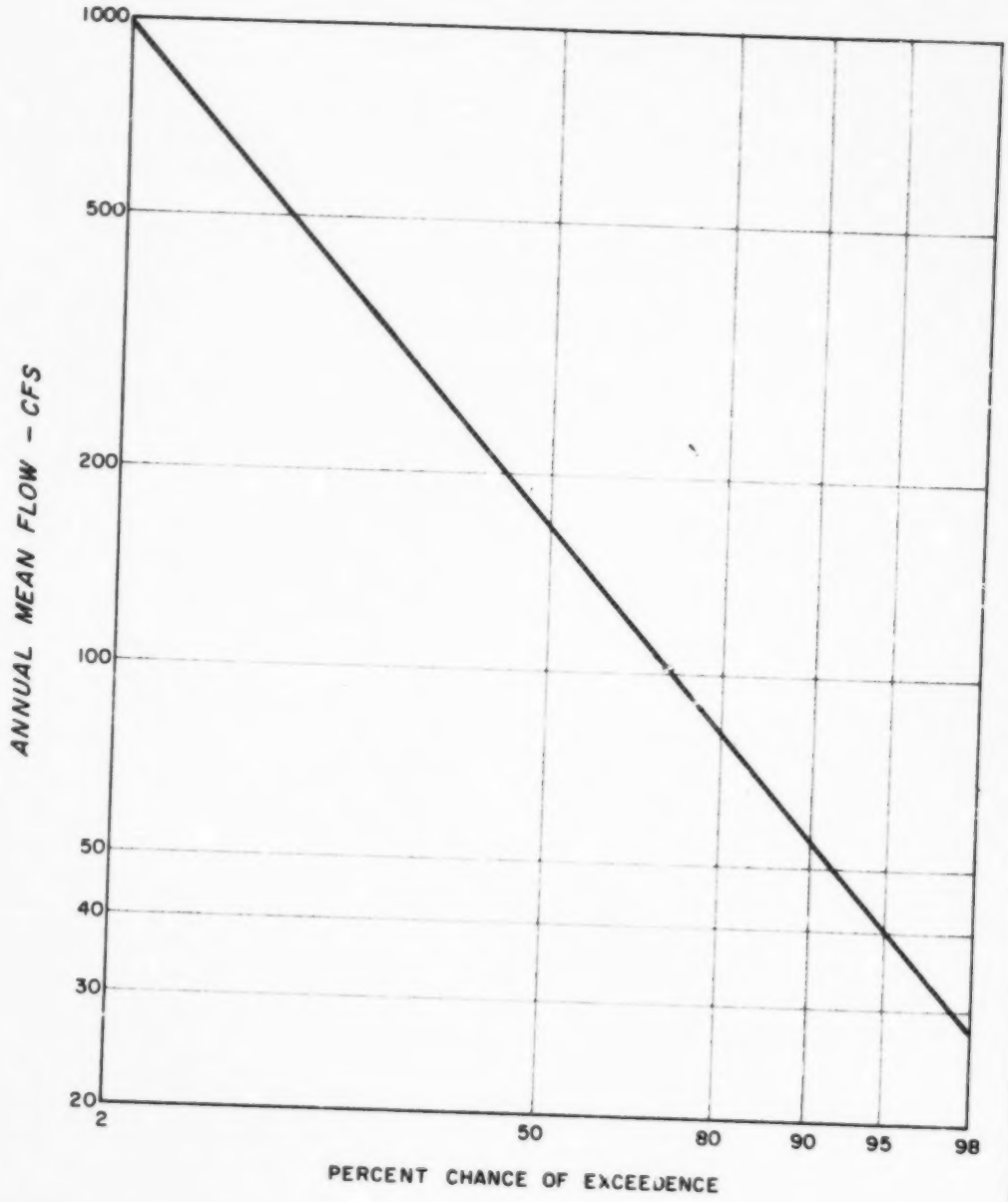
Quality

The quality of the Chikaskia River water is among the finest in the State. Presented in table V-2 are water quality measurements at various stations in the basin.

Ground Water

Availability and Quality

Principal ground water supply in the area is found in the alluvium underlying the flood plains and terraces along the Chikaskia



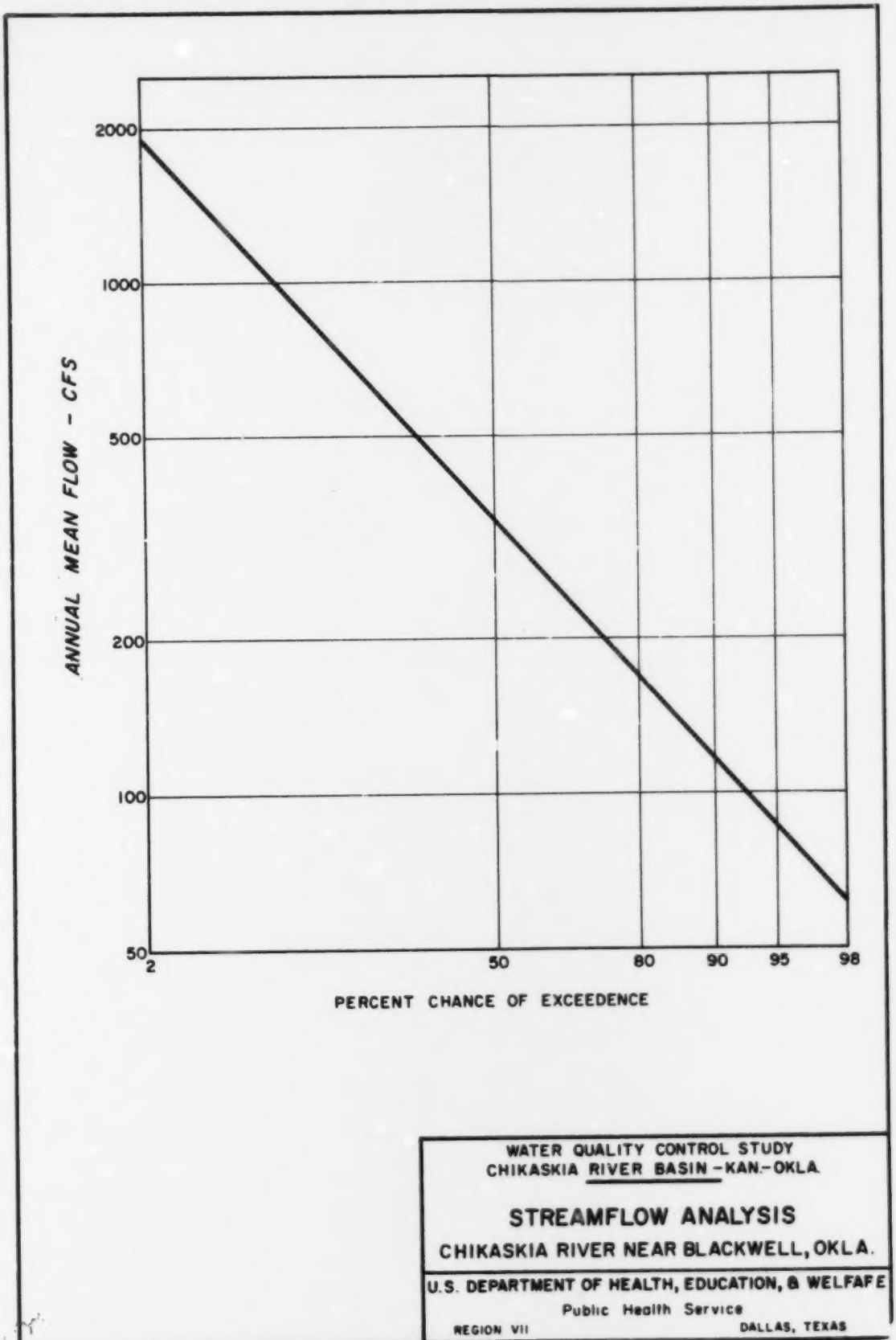
WATER QUALITY CONTROL STUDY
CHIKASKIA RIVER BASIN – KAN.–OKLA.

STREAMFLOW ANALYSIS

CHIKASKIA RIVER NEAR CORBIN DAMSITE

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
Public Health Service
REGION VII DALLAS, TEXAS

FIGURE V–1



WATER QUALITY CONTROL STUDY
CHIKASKIA RIVER BASIN - KAN.-OKLA.

STREAMFLOW ANALYSIS

CHIKASKIA RIVER NEAR BLACKWELL, OKLA.

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
Public Health Service
REGION VII DALLAS, TEXAS

FIGURE V-2

Table V-1

Chikaskia River Basin - Streamflow Analysis
(cfs)

Chikaskia River near Corbin, Kansas

	% of Yearly Flow	Exceedence Interval 90%	95%	98%
Jan	5.1	34	24	17
Feb	6.3	41	30	21
Mar	8.3	55	40	28
Apr	8.2	54	39	28
May	13.9	92	68	47
June	15.3	101	73	50
July	12.5	82	60	42
Aug	4.7	31	23	16
Sept	9.4	62	45	32
Oct	5.6	37	27	19
Nov	5.3	35	25	18
Dec	5.4	36	26	18
Mean Monthly Flow		55	40	28

Annual Mean Flow for 13 years
220 cfs

Drainage Area = 794 sq. mi.

Chikaskia River near Blackwell, Okla.

	% of Yearly Flow	Exceedence Interval 90%	95%	98%
Jan	3.6	52	38	27
Feb	5.3	76	56	39
Mar	7.5	108	79	56
Apr	12.6	181	133	94
May	23.9	344	252	177
June	22.6	325	239	168
July	7.7	111	81	57
Aug	3.3	48	35	25
Sept	3.0	43	32	22
Oct	3.6	42	38	27
Nov	3.3	48	35	25
Dec	3.6	52	38	27
Mean Monthly Flow		120	88	62

Annual Mean Flow for 28 years
482 cfs

Drainage Area = 1,859 sq. mi.

Bluff Creek at Fall Creek, Kansas

	% of Yearly Flow	Exceedence Interval 90%	95%	98%
Jan	2.3	1.7	0	0
Feb	1.5	1.1	0	0
Mar	7.6	5.5	0	0
Apr	12.9	9.3	0	0
May	20.5	14.8	0	0
June	31.1	22.9	0	0
July	4.5	3.2	0	0
Aug	3.8	2.7	0	0
Sept	4.9	3.5	0	0
Oct	0.8	0.6	0	0
Nov	6.8	4.9	0	0
Dec	3.3	2.4	0	0
Mean Monthly Flow		6.0	0	0

Annual Mean Flow for 27 years
133 cfs

Drainage Area = 545 sq. mi.

main stem and appears adequate for the present small municipal and irrigational withdrawals. The chemical quality of ground water in the study area is similar to that of surface water in the area. (See table V-3.)

Table V-2

Chemical Quality - Chikaskia River Basin Surface Water

			Dissolved Solids	Sulfates	Chlorides
U. S. Public Health Service upper Limits 6/			500	250	250
Location	Period of Record				
Chikaskia River at Corbin	9/50-9/51, 12/56-9/61	Max.	383	80	40
		Min.	134	13	5
Arith Mean (For the Period of Record)			305	49	24
Bluff Creek at Anthony	10/14/02-12/11/02		340	95	24
	9/19/08		566	131	76
Fall Creek at Caldwell	1/7/08		578	147	67

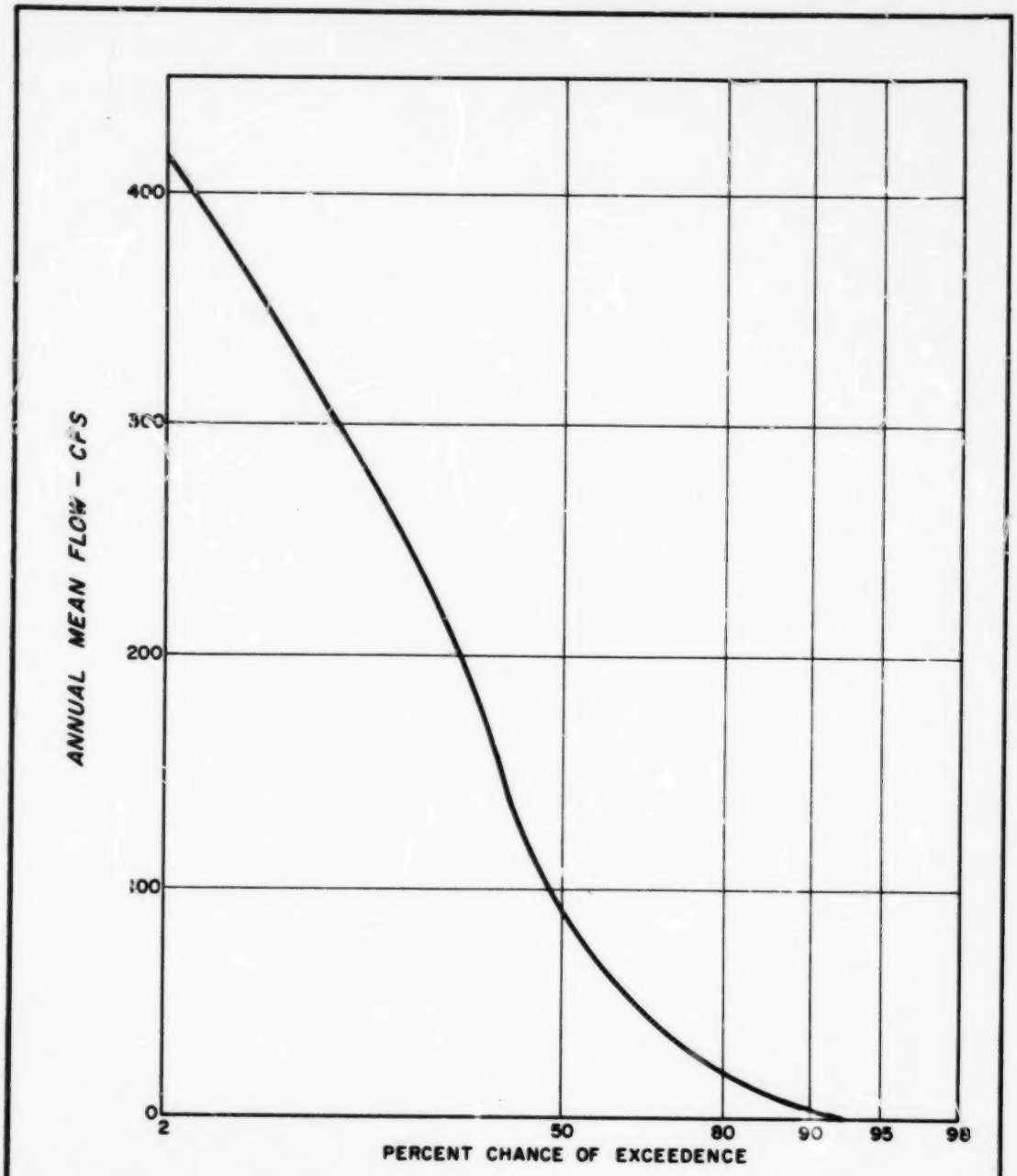
Source: Kansas State Department of Health 7/

Table V-3

Chemical Quality - Study Area Municipal Ground Water Supplies

City	Dissolved Solids	Sulfates	Chlorides
Anthony	465	61	30
Harper	315	18	22
Caldwell	390	62	31
Wellington	552	115	87

Source: Kansas State Department of Health 8/



WATER QUALITY CONTROL STUDY
CHIKASKIA RIVER BASIN - KAN.-OKLA.

STREAMFLOW ANALYSIS

BLUFF CREEK AT FALL CREEK CONFLUENCE

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
Public Health Service
REGION VII DALLAS, TEXAS

FIGURE V-3

VI. WATER REQUIREMENTS - MUNICIPAL AND INDUSTRIAL

Present Water Use

Combined water use for the principal communities in the study area presently totals about 4.4 mgd as shown in table VI-1. This is an average of about 170 gallons per capita per day (gpcd).

Table VI-1

Combined Water Use for the Principal Communities in the Study Area

Community	Present Average Demand (mgd)	Source
Anthony, Kansas	0.50	3 shallow wells
Harper, Kansas	0.38	Wells
Caldwell, Kansas	0.18	12 shallow wells
Wellington, Kansas	0.80	Lake Wellington & 24 shallow wells
Blackwell, Oklahoma	2.50	Chikaskia River & Lake Blackwell
Total	4.36	

Source: Public Health Service 9/

As shown in table VI-1, the smaller communities in the study area are presently using shallow wells for municipal supplies. Wellington augments its ground water supply with surface storage in Lake Wellington, a small municipal reservoir on a Chikaskia River tributary. Blackwell, Oklahoma, obtains its water supply from the Chikaskia River and storage in Lake Blackwell.

Future Water Use

Projected populations and water use for communities in the study area are presented below in table VI-2. All projections are made by the Bureau of Reclamation 10/ except the Blackwell, Oklahoma area projections, which were made in a previous Public Health Service study. 11/

Table VI-2

2020 Population and Water Use Projections
Chikaskia River Study Area

Community	Population	Municipal and Industrial Water Demand (mgd)
Anthony, Kansas	3,000	0.50
Harper, Kansas	2,200	0.32
Caldwell, Kansas	2,000	0.29
Wellington, Kansas	10,120	2.41
Blackwell, Oklahoma	18,000	3.30
TOTAL	35,320	6.82

Per capita water consumption averages approximately 190 gpcd.

It is anticipated that municipal and industrial water use by the above communities will be the principal source of waste discharge to study area streams in future years.

VII. WATER QUALITY CONTROL

General

If maximum use is to be made of a region's water resources, it is imperative that the area's streams be protected from natural and manmade pollution. Otherwise, potential water uses such as for municipal and industrial water supplies and/or fish and wildlife and recreation purposes may be excluded.

Congress emphasized the importance of water quality control as it applies to our Nation's water resources by the enactment of the Federal Water Pollution Control Act, Public Law 84-660 as amended (33 USC 466 et seq.). Under the provisions of this act, consideration must be given to the inclusion of storage, in any reservoir being planned by a Federal agency, for regulation of streamflow to control water quality. Storage and release of this water are not to be provided as a substitute for adequate treatment of wastes at the source.

Municipal, Industrial, and Agricultural Pollution

Principal communities currently discharging wastes to study area streams include the towns of Anthony, Harper, Caldwell, and Wellington, Kansas, and Blackwell, Oklahoma.

Anthony is located near Bluff Creek about 25 miles above the proposed Caldwell damsite. Present waste discharges from the town average about 0.28 mgd (Population Equivalent (P.E.) 800) 12/ and are released to the periodically dry creek.

The town of Harper discharges its wastes to Sand Creek approximately 14 miles above confluence with the Chikaskia River and about 35 miles above the proposed Corbin damsite. Present waste discharges from the town average about 0.18 mgd (P.E. 290). 12/ Sand Creek is also periodically dry.

The city of Caldwell releases its wastes to Fall Creek which joins Bluff Creek about 7 miles below the proposed Caldwell damsite. Waste flow from the town now averages about 0.19 mgd and has estimated P.E. of 350. 12/ As shown by figure V-3, streamflow in Bluff Creek (measured at the confluence with Fall Creek) drops to zero between 5 and 10 percent of the time.

The city of Wellington presently discharges its sewage to Slate Creek, a tributary of the Arkansas River. Waste flows from Wellington which now average about 0.88 mgd (P.E. 1,300) 12/ will have no apparent effect on water quality in the Chikaskia River basin.

Blackwell, Oklahoma, discharges its wastes directly to the Chikaskia River about 14 miles above confluence of the river with the Salt Fork of the Arkansas. Present waste flows from Blackwell average about 1.0 mgd with a P.E. of 1,300.

All of the above communities presently provide secondary waste treatment of removal of about 85 percent of the biochemical oxygen demand (BOD). 12/

Present irrigation return flows to the Chikaskia River appear negligible. Total estimated cropland under irrigation within the river basin in 1959 was less than 1,000 acres. The basin has a total of about 21,000 irrigable acres, most of which lie in Sumner County, Kansas, and Kay County, Oklahoma.

Principal sources of future pollution in the Chikaskia River basin are expected to be the municipal waste releases from the various communities in the watershed.

By the year 2020 it is anticipated that total municipal waste flows to streams in the study area will have increased to 4.8 mgd with a BOD loading after treatment of about 1.2 tons per day.

Water Quality Objectives

Appraisal of future stream condtitions and the subsequent need for water quality control in the Chikaskia River basin is based on parameters of water quality which are currently available for use. Dissolved oxygen consumption is used as a measure of the organic waste load (those constituents which will decompose in the stream). The dissolved oxygen content of streams is a principal factor in maintenance of an environment necessary for propagation of fish and other aquatic life and for the avoidance of nuisance conditions.

Dissolved solids are employed to characterize the effects of stable pollutants (those constituents which are not utilized or reduced by the stream environment) such as chloride and sulfate salts.

These constituents are generally not affected in the treatment of municipal wastes. Because of cathartic effects and taste, and laxative properties, dissolved solids in excessive amounts are undesirable in waters used for public water supplies. As indicated earlier, the present dissolved solids level in study area streams is well below the upper limits of the Public Health Service Drinking Water Standards, 1962. 6/

To investigate the need for water quality control storage in study projects, the following criteria or conditions were assumed: Projected municipal effluents will be sufficiently treated to remove 85 percent of the BOD; a dissolved oxygen content of 4 milligrams per liter (mg/l) or more should be maintained in the receiving streams if fish and wildlife uses are to be preserved and nuisance conditions avoided; the ultimate first stage BOD loading of municipal wastes in this area will be 0.30 pounds per capita per day by the year 2020; no dissolved solids removal will be achieved by treatment; uniform mixing of wastes and receiving waters will occur; and control of water quality is desirable when the concentrations of dissolved solids and other chemical constituents in finished drinking water supplies exceed the upper limits of the Public Health Service Drinking Water Standards-1962. 6/

Flow Regulation

In determining the amount of water from storage required to maintain satisfactory stream quality in the Chikaskia River basin and adjoining tributaries, it is important that recognition be given to those flows which occur naturally in the stream. Since these flows provide a measure of the river's natural waste assimilative capacity, they are used as a basis in establishing the need for flow regulation or releases to maintain water quality at the following locations.

Blackwell

No future pollution problem is expected from adequately treated waste flows in this area. The expected natural streamflow of the Chikaskia River at Blackwell, even during periods of low flow and with Corbin and Caldwell Reservoirs in operation, appears sufficient to assimilate adequately treated waste flows from the city beyond the year 2020.

Harper

As mentioned earlier, Harper, Kansas, discharges its wastes to East Sand Creek. This tributary may become polluted for a short distance during extreme low flows. A possible solution to this

problem would be the piping of the waste discharges to the Chikaskia River by gravity flow. The flow of the Chikaskia River at the East Sand Creek confluence is more than sufficient to assimilate Harper's projected treated waste loads.

Anthony

Waste flows from Anthony, Kansas, will enter Bluff Creek several miles above the Caldwell damsite. The length of stream between these points may become polluted during extreme low flows; however, the volume of the water in storage in Caldwell Reservoir 13/ will be sufficient to assimilate the projected pollution loading from Anthony, based on a method of evaluation suggested by S. M. Drachev. 14/

Caldwell

Since extended periods of zero flow have occurred in Bluff Creek below the Fall Creek confluence, an immediate need for water supply storage in Caldwell Reservoir to provide streamflow regulation for water quality control below the town of Caldwell is indicated.

The minimum streamflow (or releases with the reservoir in place) needed in Bluff Creek at the Fall Creek confluence to maintain satisfactory water quality is given below in table VII-1 on a monthly basis.

Table VII-1

Minimum Reservoir Releases
Needed for Quality Control*
Bluff Creek at Fall Creek, Kansas

Month	Minimum Release (Ac.-Ft./Mo.)
January	0
February	0
March	9
April	18
May	28
June	37
July	56
August	56
September	28
October	19
November	9
December	0

*Assumes no uncontrolled runoff downstream from Caldwell damsite.

Seepage losses from Caldwell Reservoir as estimated in the Bureau of Reclamation Caldwell Reservoir study 13/ will be in the neighborhood of 300 acre-feet per month. This would be more than sufficient to provide minimum streamflows shown in table VII-1. On this basis, there will be no need for storage in Caldwell Reservoir for water quality control. In the event these seepage losses do not occur as expected, supplemental releases from the reservoir will be needed to maintain adequate streamflow, assuring satisfactory levels of DO. In absence of this project, however, Bluff Creek below Fall Creek will be periodically polluted during periods of low or zero flow. Based on the plan of operation proposed by the Bureau of Reclamation, releases from Corbin Reservoir will be negligible during periods of low streamflow. 1/ However, the expected natural runoff of the Chikaskia River between Corbin damsite and confluence with Bluff Creek appears adequate to assimilate this polluted flow. (See table VII-2.) Treated waste discharges from the town of Caldwell are therefore not expected to pollute the mainstream of the Chikaskia River with Corbin Reservoir in operation.

Table VII-2

Expected Natural Runoff - Chikaskia River between Corbin Damsite and Bluff Creek Confluence a/

Month	Ac.-Ft./Month
January	13.5
February	16.6
March	21.9
April	21.6
May	36.7
June	40.4
July	33.0
August	12.4
September	24.8
October	14.8
November	14.0
December	14.3

a/Based on streamflow characteristics at Corbin damsite and 98 percent exceedence interval or drought recurrence interval of once in 50 years.

VIII. BENEFITS

General

Based on information presently available, and in view of expected seepage losses from Caldwell Reservoir there would be no need for water supply storage for water quality control purposes in the proposed Corbin and Caldwell Reservoirs. However, in absence of Caldwell Reservoir there will be periods when streamflow in the reach of Bluff Creek below the Fall Creek confluence is composed entirely of waste flows from the town of Caldwell. As pointed out in Chapter VII, extended periods of zero flow have occurred in this reach of the stream.

Without necessary dilution water, the stream will have less dissolved oxygen for a distance of about 10 miles below the town of Caldwell. Due to pollution in the stream, fish and wildlife which might otherwise be attracted to the area will stay away in favor of waters that more nearly provide the environment they require. The stream will become the source of various odors and paint-blackening fumes, and will be worthless for recreational purposes.

By constructing Caldwell Reservoir, these conditions can be prevented due to the diluting effect of the small but effective seepage losses from the reservoir. Satisfactory dissolved oxygen levels necessary for propagation of fish and wildlife will be maintained in the stream. Adequately treated waste discharges from the city of Caldwell which will otherwise be determental to the stream environment would then aid in encouraging propagation of fish and wildlife and recreational uses of the stream.

Although expected seepage losses containing adequate dissolved oxygen from the reservoir will forego the need for storage for downstream water quality control purposes, the project will be of value in the improvement of water quality in the reach of Bluff Creek between the damsite and confluence with the Chikaskia River.

Evaluation of Benefits

Senate Document No. 97 permits the following method of measuring the value of benefits to flow regulation or water quality control by a Federal reservoir.

> "In stiuations where no adequate means can be devised to evaluate directly the economic effects of water quality improvement, the cost of achieving the same results by the most likely alternative may be used as an approximation of value."

This alternative cost method was used to determine the value of water quality control by Caldwell Reservoir.

Several alternative plans could possibly be developed to maintain satisfactory water quality in Bluff Creek and/or prevent nuisance conditions from occurring in the stream in absence of Caldwell Reservoir. Those considered most feasible or applicable to the situation at hand include: (1) Constructing a small single-purpose reservoir either on Bluff Creek or Fall Creek to regulate streamflow for control of water quality. (2) Piping treated municipal and industrial waste flows from the town of Caldwell to the Chikaskia River - approximately 7 miles away. (3) Spreading or distributing adequately treated wastes from the city over a suitable ground surface and allowing it to evaporate or seep into the ground.

Of the three alternatives investigated, the latter appears to be the least costly. However, this alternative must be evaluated in light of inherent disadvantages and potential hazards. By allowing the waste waters to evaporate or soak into the water table, a potential surface water resource is partially, if not totally, lost. Spreading is generally considered hazardous because little purification of inorganics occurs in seepage through the ground, and the underlying ground water could, therefore, be polluted with the wastes.

However, possibilities of ground water pollution in this instance appear remote. A land disposal site could be located northeast of Caldwell toward the Chikaskia River and away from the city's present alluvial ground water supply along Fall Creek. Soils in the proposed site area belong to the Pleistocene Series and are composed of silt, clay, and fine to coarse sand and gravel. 15/ Ground water yields on a per well basis in this area would be less than 50 gpm. 16/ It is expected that future treated waste discharges from the city will be primarily of an organic nature and would generally be improved by passage through the soil. Projected waste flows are also relatively small in magnitude - about 0.3 mgd by the year 2020. Since the potential disposal area is in a region of high evaporation (higher than all but the extreme southwestern portions of the Nation) 17/ a good portion of the distributed wastes will evaporate.

Based on the foregoing considerations, spreading is considered a feasible alternative to water quality control in Bluff Creek in absence of Caldwell Reservoir. It would require piping the treated municipal and industrial waste flows a safe distance from town (two miles assumed) and spreading over a three-acre tract of land surrounded by a dike and fencing.

The total cost of spreading including land, dike construction, fencing, and engineering fees, but excluding cost of transporting

wastes to the site is estimated to be $7,690. a/ Annual cost would be $390 for maintenance, $305 for amortization at 3 1/8 percent per annum for 50 years, and $4,435 b/ for transmission of wastes to the site. On this basis, the average annual benefit to control of water quality in Bluff Creek by Caldwell Reservoir is estimated to be $5,130.

For purposes of comparison, the estimated annual cost of piping the communities treated waste flows to the Chikaskia River is $15,525. b/ Annual costs of storage in a single-purpose project to provide flow regulation comparable to expected seepage would be substantially greater than this amount.

Since water quality control management by the proposed Caldwell Reservoir will assure water quality in Bluff Creek to its confluence with the Chikaskia River and thereby provide recreational opportunities for residents in Harper, Sumner, Grant, and Kay Counties, benefits to improvement of water quality in Bluff Creek by the reservoir are considered widespread in scope.

a/ Costs of spreading (excluding waste transmission) are based on results presented in the Public Health Service paper - AWTR-3 "Ultimate Disposal of Advanced Waste Treatment." 18/

b/ Costs of waste transmission are based on waste water transmission cost curves developed by the Office of Saline Water Conversion 19/ with revisions to reflect present day prices.

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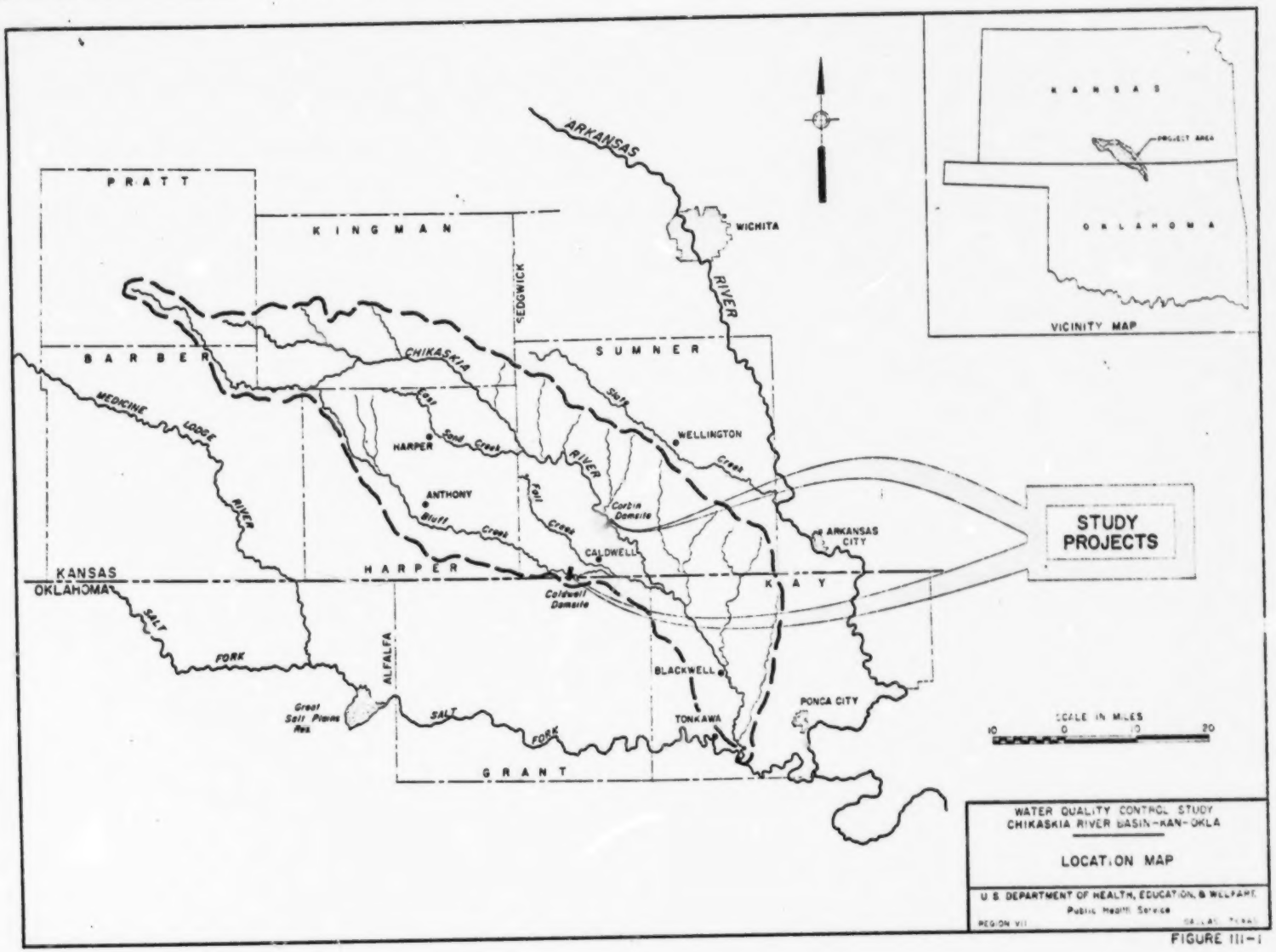
KANSAS
PROJECT AREA
OKLAHOMA
VICINITY MAP
PRATT
KINGMAN
SEDGWICK
WICHITA
ARKANSAS
RIVER
BARBER
SUMNER
CHIKASKIA
MEDICINE LODGE RIVER
HARPER
Sand Creek
WELLINGTON
Slate Creek
ANTHONY
Bluff Creek
Fuel Creek
Corbin Domsite
CALDWELL
Caldwell Domsite
ARKANSAS CITY
STUDY PROJECTS
KANSAS
OKLAHOMA
HARPER
KAY
SALT FORK
ALFALFA
Great Salt Plains Res
BLACKWELL
TONKAWA
PONCA CITY
GRANT
SCALE IN MILES
10 0 10 20
WATER QUALITY CONTROL STUDY
CHIKASKIA RIVER BASIN-KAN-OKLA
LOCATION MAP
U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
Public Health Service
REGION VII

FIGURE III-1